

PATENT ABSTRACTS OF JAPAN

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(71)Applicant : YAMAHA CORP

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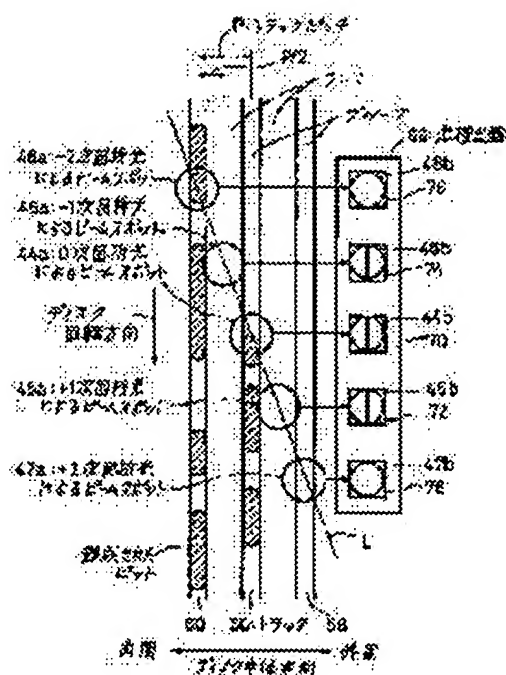
(72)Inventor : NAGANO HISASHI

(54) OPTICAL HEAD AND OPTICAL DISK RECORDER

(57)Abstract:

PROBLEM TO BE SOLVED: To make possible optimum laser power adjustment, verification and foreseeing of a scratch, etc., of a disk in real-time at a recording time while performing precise tracking using a differential tracking system by dividing laser beam from a semiconductor to five pieces of diffracted light and detecting them.

SOLUTION: The laser beam outgoing from a semiconductor laser is divided into five pieces of beam of zero-order diffracted beam, ± 1 st-order diffracted beam and ± 2 nd-order diffracted beam, and they are placed as follows to be detected individually. When the beam spot 44a of the zero-order diffracted beam is placed on a track 56, the beam spot 47a of +2nd-order diffracted beam is placed on the an external track 58 adjacent to it, and the beam spot 45a of the +1st-order diffracted beam is placed on the middle of them. Further, the beam spot 48a of -2nd diffracted beam is placed on the an internal track 60 adjacent to the track 56 on which the beam spot 44a of the zero-order diffracted beam is placed, and the beam spot 46a of -1st-order diffracted beam is placed on the middle between the beam spot 44a of the zero-order diffracted beam and the beam spot 48a of the -1st-order diffracted beam.



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CLAIMS

[Claim(s)]

[Claim 1] The semiconductor laser which carries out outgoing radiation of the one laser beam, and the diffraction grating which is arranged at the laser beam outgoing radiation side of this semiconductor laser, and divides into at least five light of the zero-order diffracted light, the primary [**] diffracted light, and the secondary [**] diffracted light the laser beam concerned by which outgoing radiation was carried out, When the beam spot of said zero-order diffracted light is located on one truck of an optical disk It is located on the truck of 1 outside where the beam spot of the aforementioned +secondary diffracted light adjoins it. The beam spot of the aforementioned +primary diffracted light is located in the middle of the beam spot of said zero-order diffracted light, and the beam spot of the aforementioned +secondary diffracted light. It is located on the truck of 1 inside with which the beam spot of the aforementioned -secondary diffracted light adjoins the truck in which the beam spot of said zero-order diffracted light is located. So that the beam spot of the aforementioned -primary diffracted light may be located in the middle of the beam spot of said zero-order diffracted light, and the beam spot of the aforementioned -secondary diffracted light The optical system which draws these zero-order diffracted light, the primary [**] diffracted light, and the secondary [**] diffracted light common to the recording surface of an optical disk, The optical head which comes to provide the photodetector which has two or more light-receiving sides which detect each reflected light from the disk of said zero-order diffracted light, the primary [**] diffracted light and the secondary [**] diffracted light or said zero-order diffracted light, the primary [**] diffracted light and the +secondary diffracted light, or the -secondary diffracted light according to an individual.

[Claim 2] Using the optical head of said claim 1, modulate said laser beam by the record signal, and an optical disk is irradiated. It is the optical disk recording device which performs sequential record on the truck by the side of a periphery from the truck by the side of the inner circumference of the disk concerned. Said zero-order diffracted light has optical reinforcement required for record for the reinforcement of the laser beam for record which carries out outgoing radiation from said semiconductor laser. It adjusts so that the aforementioned primary [**] diffracted light and the secondary [**] diffracted light may not have optical reinforcement required for record but may have optical reinforcement required for playback. And the asymmetry value of the regenerative-signal component contained in the light-receiving signal of the -secondary diffracted light detected with said photodetector while recording by said zero-order diffracted light is calculated. The laser beam adjustment device on the strength which controls by real time the reinforcement of the laser beam for record which carries out outgoing radiation from said semiconductor laser so that a predetermined asymmetry value may be acquired, The optical disk recording device which comes to provide the tracking servo system which detects a tracking error by the differential push pull method using the light-receiving signal of the zero-order diffracted light detected with said photodetector at the time of record, and the primary [**] diffracted light, and performs tracking control.

[Claim 3] Using the optical head of said claim 1, modulate said laser beam by the record signal, and an optical disk is irradiated. It is the optical disk recording device which performs sequential record on the

truck by the side of a periphery from the truck by the side of the inner circumference of the disk concerned. Said zero-order diffracted light has optical reinforcement required for record for the reinforcement of the laser beam for record which carries out outgoing radiation from said semiconductor laser. The laser beam adjustment device on the strength adjusted so that the aforementioned primary [**] diffracted light and the secondary [**] diffracted light may not have optical reinforcement required for record but may have optical reinforcement required for playback, The tracking servo system which detects a tracking error by the differential push pull method using the light-receiving signal of the zero-order diffracted light detected with said photodetector at the time of record, and the primary [**] diffracted light, and performs tracking control, The optical disk recording device which comes to provide the verification means which verifies the data which compared the record signal of the regenerative-signal component contained in the light-receiving signal of the -secondary diffracted light detected with said said photodetector at the time of record, and were recorded on the optical disk.

[Claim 4] Using the optical head of said claim 1, modulate said laser beam by the record signal, and an optical disk is irradiated. It is the optical disk recording device which performs sequential record on the truck by the side of a periphery from the truck by the side of the inner circumference of the disk concerned. Said zero-order diffracted light has optical reinforcement required for record for the reinforcement of the laser beam for record which carries out outgoing radiation from said semiconductor laser. The laser beam adjustment device on the strength which needs the aforementioned primary [**] diffracted light and the secondary [**] diffracted light for record and which is adjusted so that it may not have the degree of **** but may have optical reinforcement required for playback, The tracking servo system which detects a tracking error by the differential push pull method using the light-receiving signal of the zero-order diffracted light detected with said photodetector at the time of record, and the primary [**] diffracted light, and performs tracking control, The optical disk recording device which comes to provide a truck quality judging means to reduce the loop gain of said tracking servo system when the quality of the truck before record is judged using the light-receiving signal of the +secondary diffracted light detected with said photodetector at the time of record and it judges with it being poor.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] It enables precognition of the blemish on optimal laser power adjustment on real time, verification, and a disk etc. at the time of record, this invention performing the highly precise tracking using a differential tracking method about the optical head of a new configuration, and the optical disk recording device using this optical head.

[0002]

[Description of the Prior Art]

(1) The tracking control system of the optical disk recording apparatus of the tracking control former had the 3 beam method and the common push pull method. Before and after a main beam, the 3 beam method shifts two subbeams from a truck core a little to a longitudinal direction, irradiates, detects the difference of the amount of disk reflected lights of these two subbeams, and detects a tracking error. The push pull method receives the light by which reflection diffraction was carried out by the pit and guide rail on a disk with 2 division photodetector by which symmetry arrangement was carried out to the truck core, and detects a tracking error according to the difference of the light income in the two light sensing portions.

[0003] Although the 3 beam method was most stable approach as an object for playback, when this was used for record, the amounts of reflected lights differed and the spot of the subbeam which carries out backward to the spot of the subbeam to precede passing through the non-Records Department had the fault which offset produces to a tracking error signal in order to pass through the existing Records Department.

[0004] On the other hand, by the push pull method, when the objective lens shifted, or it curved in the direction of the diameter of a disk and the inclination etc. had arisen, offset arose to the tracking error signal and there was a fault it becomes impossible for the amount of tracking flatteries to fully secure.

[0005] As a tracking control system which canceled the fault of the 3 beam method of these former, or the push pull method, there are some which are called the so-called differential push pull method. This subtracts two signals for every 2 division detector, acquires three push pull signals, it calculates these by predetermined operation expression so that offset may be negated, and it shifts 1/2 track pitch of three beam spots at a time to a truck longitudinal direction, they are arranged to it in the location of a truck cross direction, and 2 division photodetector detects the reflected light of each spot, respectively, and it detects a tracking error.

[0006] (2) Since the optimal write-in power of the laser beam at the time of setting optical disk record of the optimal write-in power changes with classes of optical disk, before performing actual record (real record) of an input signal, trial writing is performed beforehand, and the optimal write-in power is set up. For example, CD-Write By Once (CD-WO) specification, the optimal write-in power is set up by a series of actuation which the area which performs this trial writing is established in the most inner circumference of a disk as PCA (Power Calibration Area), and is called OPC (Optimum Power Control).

[0007] The OPC actuation in the conventional optical disk recording device defined the write-in power

value from which a certain value (for example, 0.04) which is changed a step every, performs a test record, computes an asymmetry value (index which shows the asymmetry of HF signal) by reproducing this area recorded the account of a test, and is made into the optimal asymmetry value is acquired in write-in power as an optimal write-in power value, and had set this up as a write-in power value at the time of real record.

[0008] (3) In advance of the write-in power control real record for writing in by holding the optimal write-in power, the reflected light level of the record part of the optical disk recorded by the optimal write-in power is detected, and sample hold of the reflected light level is carried out in a sample hold circuit, carry out the AD translation of the level in an AD translation circuit, process the value in an arithmetic circuit, and memorize the value as desired value of ALPC (Automatic Laser Power Control) to CPU.

[0009] And at the time of real record, record laser power is controlled so that the desired value which detects the reflected light level of a record part at any time, carries out sample hold of the reflected light level in said sample hold circuit, carries out the AD translation of the level in an AD translation circuit, processes the value in said arithmetic circuit, and is recorded on said CPU in the ALPC circuit, and its value are in agreement.

[0010] (3) Reproduce the part recorded after verification real record termination, and verify as contrasted with the record data of a basis.

[0011]

[Problem(s) to be Solved by the Invention] Since OPC actuation was performed in advance of real record, the conventional optical disk recording device had the problem which will require time amount before starting real record. Moreover, ALPC actuation while performing real record needed complicated circuitry, and there were many components mark, and it had the problem which leads to a cost rise or a size rise. Moreover, even if OPC actuation once performed real record in quest of optimal record laser power, it was not able to respond to fluctuation of the optimal laser power value by dispersion in the property at the time of record by the direction location of the diameter of a disk etc. Moreover, in order to perform verification by reproducing a record part after real record termination, it had required time amount long from a real recording start to verification termination. Moreover, when it had the blemish on the disk, it might become a lifting and write-in impossible about the error at the time of real record.

[0012] It tends to offer the optical head which enabled precognition of the blemish on optimal laser power adjustment on real time, verification, and a disk etc. at the time of record, and the optical disk recording device using this optical head, this invention solving the trouble in said Prior art, and performing the highly precise tracking using a differential tracking method.

[0013]

[Means for Solving the Problem] When one laser beam is divided into at least five light of the zero-order diffracted light, the primary [**] diffracted light, and the secondary [**] diffracted light and the beam spot of the zero-order diffracted light is located on one truck of an optical disk, the optical head of this invention + It is located on the truck of 1 outside where the beam spot of the secondary diffracted light adjoins it. + The beam spot of the primary diffracted light is located in the middle of the beam spot of the zero-order diffracted light, and the beam spot of the +secondary diffracted light. - It is located on the truck of 1 inside with which the beam spot of the secondary diffracted light adjoins the truck in which the beam spot of the zero-order diffracted light is located. - So that the beam spot of the primary diffracted light may be located in the middle of the beam spot of the zero-order diffracted light, and the beam spot of the -secondary diffracted light It arranges, respectively and the reflected light from the disk of each diffracted light is detected according to an individual (however, about the secondary [**] diffracted light, it may only be sufficient to receive only one reflected light of the +secondary diffracted light or the -secondary diffracted light depending on a use gestalt). It is made like.

[0014] Moreover, using the above-mentioned optical head, the optical disk recording apparatus of this invention modulates a laser beam by the record signal, irradiates an optical disk, is an optical disk recording apparatus which performs sequential record on the truck by the side of a periphery from the truck by the side of the inner circumference of a disk, records using the zero-order diffracted light, and is

made to perform tracking control by the differential push pull method using the light-receiving signal of zero-order light and the primary [**] diffracted light. Moreover, it is made to verify by performing the optimal power adjustment, detecting the asymmetry value of the regenerative-signal component contained in the light-receiving signal of the -secondary diffracted light (light which carries out backward to the zero-order diffracted light for record), and recording by the zero-order diffracted light, or comparing the record signal of the regenerative-signal component contained in the light-receiving signal of the -secondary diffracted light, recording by the zero-order diffracted light. Moreover, when defects, such as a blemish of the truck before record, are detected using the +secondary diffracted light (light preceded with the zero-order diffracted light for record) and a defect is detected, he is trying to prevent the truck blank by the blemish by reducing the loop gain of a tracking servo system.

[0015] In addition, since the record signal component besides a regenerative-signal component is contained in the light-receiving signal of the -secondary diffracted light at the time of record, in the optimal power adjustment or verification, a record signal component is removed from the light-receiving signal of the -secondary diffracted light, and only a regenerative-signal component is extracted. - Since the light-receiving signal of the +secondary diffracted light which is tracing the non-recording track top, for example consists only of a record signal component as an approach of removing a record signal component from the light-receiving signal of the secondary diffracted light, there is a method of subtracting the light-receiving signal of the +secondary diffracted light from the light-receiving signal of the -secondary diffracted light. Or it can replace with the light-receiving signal of the +secondary diffracted light, and can also subtract from the light-receiving signal of the -secondary diffracted light using the signal before record (driving signal of semiconductor laser) itself.

[0016] As mentioned above, according to the optical disk recording device of this invention, precognition of the blemish on optimal laser power adjustment on real time, verification, and a disk etc. is possible at the time of record, performing the highly precise tracking using a differential tracking method.

[0017]

[Embodiment of the Invention] The gestalt of implementation of this invention is explained below.

Drawing 2 shows the outline of the optical disk record regenerative apparatus 10 which applied this invention. An optical disk 12 is a postscript mold disk of for example, CD-WO specification, by the spindle motor 14, a rotation drive is carried out and record and playback of a signal are performed with the optical head 18.

[0018] The record signal 16 is a signal by which eight-to-fourteen modulation was carried out for example, according to CD-WO specification. The laser driving means 20 drives the semiconductor laser in the optical head 18 according to the record signal 16 at the time of record, and the signal concerned is recorded on an optical disk 12 by the zero-order diffracted light (formation of a pit etc.). The laser beam adjustment device 22 on the strength adjusts write-in laser power on real time so that the asymmetry value of the regenerative-signal component contained in the light-receiving signal of the -secondary diffracted light at the time of record may be detected and the asymmetry value beforehand defined as an optimum value may be acquired.

[0019] The verification means 24 verifies by comparing the record signal of the regenerative-signal component contained in the light-receiving signal of the -secondary diffracted light at the time of record. When an error is detected as a result of verification, error detection information is taken out and display of error detection, redo of record, etc. are performed.

[0020] At the time of record and playback, the tracking servo system 26 uses the light-receiving signal of the primary [**] diffracted light and the zero-order diffracted light, detects a tracking error by the differential push pull method, and performs tracking control of the optical head 18. By detecting the abnormal condition (for example, HF signal being narrow and envelope signal level moving up and down greatly) of the light-receiving signal (HF signal) of the +secondary diffracted light at the time of record and playback, the truck quality judging means 28 The defect of the blemish in the truck in front of record, a fingerprint, dust, and poor record film is detected, while the location on the truck passes through a record location (location of the zero-order diffracted light), the loop gain of a truck servo is

reduced, and an unnecessary truck blank is prevented.

[0021] The light-receiving signal of the zero-order diffracted light is used for other servo system 30 at the time of record and playback, and it performs a focus servo and a spindle servo at it. Moreover, a feed servo (migration control to the direction of the diameter of a disk of the optical head 18) is also performed. At the time of playback, the playback means 32 reproduces recording information of an optical disk 12 with the light-receiving signal of the zero-order diffracted light, and outputs a regenerative signal 34.

[0022]

[Example 1] The example of the structure in the optical head 18 of drawing 2 is shown in drawing 1 R> 1. The optical head 18 carries out outgoing radiation of the one laser beam 38 from semiconductor laser 36, changes it into parallel light by the collimator lens 40, and is divided into five beams (the zero-order diffracted light 44, the +primary diffracted light 45, the - primary diffracted light 46, the +secondary diffracted light 47, - secondary diffracted light 48) by the diffraction grating 42. These five beams 44-48 go a polarization beam splitter 50 straight on, and are further irradiated by the recording surface of an optical disk 12 through the quarter-wave length plate 52 and an objective lens 54.

[0023] At this time, as shown in drawing 3, beam-spot 44a of the zero-order diffracted light 44 is located on one truck (groove) 56 of an optical disk 12. + Beam-spot 47a of the secondary diffracted light 47 is located on the truck 58 of 1 outside which adjoins it. + Beam-spot 45a of the primary diffracted light 45 is located in the middle of beam-spot 47a of the beam-spot 44 a and +secondary diffracted light 47 of the zero-order diffracted light 44. - Beam-spot 48a of the secondary diffracted light 48 is located on the truck 60 of 1 inside which adjoins the truck 56 in which beam-spot 44a of the zero-order diffracted light 44 is located. - Beam-spot 46a of the primary diffracted light 46 is located in the middle of beam-spot 48a of the beam-spot 44-[a and] secondary diffracted light 48 of the zero-order diffracted light 44. Thereby, 1/2 track pitch, the five beam spots 44a-48a shift a location in the direction of the diameter of a disk, and are arranged at a time in it. Arrangement of such the beam spots 44a-48a is realized by arrangement (include-angle setup of the direction of a grid over the direction of a truck) of a diffraction grating 42.

[0024] In drawing 1, the reflected lights 44b-48b from the optical disk 12 of five laser beams 44-48 are bent by the right angle by the polarization beam splitter 50 through an objective lens 54, are changed into focusing light with the detection lens 62, and a part goes a half mirror 64 straight on, and they are received with a photodetector 66. Moreover, other parts are bent by the right angle by the half mirror 64, and zero-order diffracted-light 44b is received with a photodetector 76 through a cylindrical lens 68.

[0025] A photodetector 76 consists of quadrisection PIN photodiodes, and is used for focal control. That is, the quadrisection photodetector 76 receives zero-order diffracted-light 44b, two addition outputs which the outputs of a diagonal location are added with an adder 104,106, and are obtained as a result subtract the four light-receiving outputs with the subtraction vessel 108, and focal error signal FE is created. Focal control is performed based on focal error signal FE.

[0026] The photodetector 66 consisted of PIN photodiodes, allotted 2 division photo detector 70 which receives zero-order diffracted-light 44b in the center, and has allotted 2 division photo detectors 72 and 74 which receive +1 order diffracted-light 45b and - diffracted-light [primary] 46b before and after that. Furthermore, the amerism photo detectors 76 and 78 which receive +2 order diffracted-light 47b and - diffracted-light [secondary] 48b before and after that are allotted.

[0027] The subtraction machine 78 subtracts and two light-receiving outputs of zero-order diffracted-light 44b received by 2 division photo detector 70 are Signals TEm. It is created, and it is added with an adder 80, and is Signal So. It is created. The subtraction machine 82 subtracts two light-receiving outputs of +primary diffracted-light 45b received by 2 division photo detector 72, and a signal TEsl is created. The subtraction machine 84 subtracts two light-receiving outputs of -primary diffracted-light 46b received by 2 division photo detector 74, and signal TEsl' is created. A photo detector 76 receives +secondary diffracted-light 47b, and is the light-receiving signal S2. It outputs. 78 receives secondary [-] photo detector diffracted-light 48b, and outputs light-receiving signal S2'.

[0028] The signal-processing network of these signals TEm, So, TEsl, TEsl', S2, and S2' is shown in

drawing 4 . the tracking servo system 26 -- the Maine spot (zero-order diffracted light) and a side spot (primary [**] diffracted light) -- each push pull signal is detected, the difference is taken, and a tracking error signal is searched for. That is, it is $TE = TE_m - G1 (TEs1 + G2 \text{ and } TEs1')$ as a tracking error signal TE amplifier 82 gives gain G2 to signal TEs1', add this and a signal TEs1 with an adder 84, amplifier 86 gives gain G1 to the addition output further, and the subtraction machine 88 subtracts Signal TE_m, and according to a differential push pull method.

It outputs. The tracking servo circuit 90 performs tracking control based on this signal TE.

[0029] In addition, gain G1 and G2 is for arranging the light-receiving signal level of zero-order diffracted-light 44b, +1 order diffracted-light 45b, and - diffracted-light [primary] 46b. It is the quantity of light ratio of the zero-order diffracted-light 44 b and **primary diffracted lights 45b and 46b : I0I1 (let light-receiving signal level of +primary diffracted-light 45 diffracted-light [-/ b and / primary] 46b be an equal.) It will be set to $G1 = I0/2I1$ $G2 = I1/I1 = 1$ if it carries out.

[0030] The truck quality judging means 28 detects the abnormal condition (for example, HF signal is narrow and envelope signal level moves up and down greatly) of the light-receiving signal S2 of the +secondary diffracted light in the blemish detector 94 (for example, a certain reference level is set up). the envelope of HF signal is detected and the envelope signal level detected is less than this reference level -- it is -- it is -- exceeding by what is detected It judges with defects, such as a blemish, being in front of 1 truck of a record location, and by the tracking gain equalization circuit 96, the loop gain of the tracking servo system 26 is reduced to a predetermined value until the defective location passes through a record location.

[0031] In addition, when error detection is performed also at the time of playback and an error is detected, the truck quality judging means 28 can prevent a playback error of skipping and others by reducing the gain of the tracking loop formation 26 to a predetermined value until a defective location passes through the playback location by the zero-order diffracted light 44.

[0032] The concrete example of change of the light-receiving signal level of the +secondary diffracted light by the blemish of a truck etc. is shown in drawing 9 (a) - (d). As a defect of a truck, as a thing on the front face of a disk, there are a blemish, fingerprint adhesion, dust, etc. and the own pinhole defect of record film etc. is one of things inside a disk. At the time of record, drawing 9 (a) is the case where there is a pinhole etc., and the reflection factor is going up it to the interior of a disk. The case where drawing 9 (b) has a blemish, a fingerprint, dust, etc. in a disk front face at the time of record is shown, and a reflection factor falls in this case. Since dust etc. intervened at the time of record, drawing 9 (c) is the case where the part in which signal record was not made is reproduced, and, in such a case, a reflection factor goes up it. Moreover, as for drawing 9 R > 9 (d), a reflection factor falls in the case where a blemish, a fingerprint, dust, etc. exist in a disk front face at the time of playback.

[0033] The laser beam adjustment device 22 on the strength subtracts the light-receiving signal S2 (signal only containing a record signal component) of the +secondary diffracted light from light-receiving signal S2' (signal containing a record signal component and a regenerative-signal component) of the secondary [-] subtraction machine diffracted light by 98, and creates the signal R, $R = S2' - S2$

[i.e.,], which consists only of a regenerative-signal component. An asymmetry value is detected inputting and real-recording this signal R on the asymmetry measuring circuit 100. In the eye pattern of the -secondary diffracted light as shown in drawing 5 , an asymmetry value sets peak value by the side of A and - to B for the peak value by the side of +, for example, is calculated by the degree type.

[0034] The asymmetry value (%) = $\{(B-A) / 2 (B+A)\} \times 100$ asymmetry measuring circuit 100 detects peak value A and B, and computes an asymmetry value by the upper type.

[0035] The laser beam equalization circuit 102 on the strength controls the reinforcement of the laser beam 38 which carries out outgoing radiation from semiconductor laser 36. That is, the reinforcement of a laser beam 38 is set up so that it may become higher than the minimum reinforcement Pw which needs the zero-order diffracted light 44 for record as shown in drawing 6 (a) at the time of record, and it may become higher than the minimum reinforcement Pr required for playback lower than the minimum reinforcement Pw which needs the primary [**] diffracted lights 45 and 46 and the secondary [**] diffracted lights 47 and 48 for record. Moreover, as shown in drawing 6 (b), all the diffracted lights 44-

48 are all lower than the minimum reinforcement P_w required for record at the time of playback, and it sets up the reinforcement of a laser beam 38 so that it may become higher than the minimum reinforcement P_r required for playback. An example of the reinforcement at the time of record of each diffracted light at the time of setting the value of standard of the laser beam reinforcement for record to 4-8mW, and setting the value of standard of the laser beam reinforcement for playback to less than 0.7mW and playback is shown in degree table (a unit is mW).

[0036]

[[At the time of playback and account [of] **]]

(One X) (two X) -0.7 -0.7 -0.7 - 0.7 [0037] (four X) Zero-order diffracted light: - 0.7 4-8 5.5-11 8-16 Primary [**] diffracted light: - 0.7 - 1 - 1.5 - 2 The secondary [**] diffracted light : Moreover, at the time of record, the laser beam equalization circuit 102 on the strength tunes the reinforcement of a laser beam 38 finely on real time so that the asymmetry value (namely, asymmetry value of the regenerative-signal component in the light-receiving signal which detected the record part on the optical disk 12 recorded by the zero-order diffracted light 44 by the -secondary diffracted light 48 by the next circumference) detected in the asymmetry measuring circuit 100 may turn into an asymmetry value (for example, 0.04) made the optimal. Since the conventional sample hold and the conventional AD translation in ALPC control are unnecessary to this fine tuning, they are easy circuitry for it and end to it.

[0038] This fine tuning can be performed according to a flow as shown in drawing 7 . That is, laser beam reinforcement is set as predetermined initial value (S1), and record is started at the beginning of a recording start (S2). Or beforehand, by OPC actuation, an optimal laser power value may be calculated and it may be set up as initial value. After a recording start holds the laser beam reinforcement at that time, when detecting an asymmetry value in the asymmetry measuring circuit 100 (S3), judging whether it is the optimal asymmetry value, and having separated from (S4) and the optimal asymmetry value, and laser beam reinforcement is adjusted (S5) and the optimal asymmetry value is acquired (S6).

[0039] In addition, as an approach of setting laser beam reinforcement as suitable initial value, without performing OPC actuation at the time of a recording start, the following approach can be considered, for example. That is, the disk ID for identifying a disk class is beforehand recorded on the non-recorded disk. Then, the certified value of the optimal record power value for every disk class (for example, 6mW at the time of ID=1 (xx disk of OO company)) ROM which memorized 7.5 etc.mW etc. is included in equipment at the time of ID=2 (**** disk of **** company). Disk ID is read at the time of record, a disk class is identified, the optimal power value defined about the disk is read from ROM, and record is started by making the value into initial value.

[0040] With the laser beam adjustment device 22 on the strength, OPC actuation and ALPC actuation are realized by real time as mentioned above at the time of record. If Disk ID is used as initial value, prior OPC actuation will become unnecessary. Moreover, even when calculating initial value in prior OPC actuation, the effectiveness that it can respond to fluctuation of the optimal record power value by the direction location of a path after a recording start etc. is acquired.

[0041] The verification means 24 verifies in the data comparator circuit 118 by comparing Signal R (regenerative signal) with Signal So (record signal). What ("1" of a bit string and "0" are contrasted directly.) EFM signals are compared for can perform this easily. In addition, Signal R is Signal So. Since it receives, is behind by about 1 round and it is detected, it is Signal So by this delay. It delays and compares. Moreover, signals R and So It replaces with comparing directly and they are Signals R and So. It can also compare, after carrying out an EFM recovery, respectively. Moreover, it is Signal So as a record signal. It can replace with and can also compare using the signal before record (the driving signal of semiconductor laser, or data in front of eight-to-fourteen modulation) itself.

[0042]

[Example 2] Other examples of this invention are shown in drawing 8 . The same sign is used for the part which is common in the example of drawing 1 . This optical disk record regenerative-apparatus 10' constitutes zero-order diffracted-light photo detector 70' in photodetector 66' of optical head 18' from a quadrisection PIN photodiode, using that light-receiving output, combines focal error detection and is

made to perform it. Therefore, the half mirror 64 and photodetector 76 in an example of said drawing 1 are excluded here, and five laser beams 44b-48b which came out of the detection lens 62 are received by photodetector 66' through a cylindrical lens 68 as they are. The output of two photo detectors A and D which are in left-hand side to a truck travelling direction among quadrisection photodiode 70' which receives zero-order diffracted-light 44b is added with an adder 110, and the output of two photo detectors B and C which are in right-hand side to a truck travelling direction is added with an adder 112. The subtraction machine 78 subtracts and two addition outputs are Signals TEm. It is created. Moreover, it is added with an adder 80 and two addition outputs are Signals So. It is created. It is Signal So at the time of playback. It uses and playback (data recovery) is performed. Others are the same as an example 1.

[0043] In addition, although the gestalt of said operation explained the case where the optical head of this invention was applied to an optical disk record regenerative apparatus, it is applicable also to an optical disk record dedicated device or an optical disk playback dedicated device. When applying to an optical disk playback dedicated device, it can constitute so that it may reproduce by the zero-order diffracted light, tracking control by the differential push pull method may be performed by the zero-order diffracted light and the primary [**] diffracted light and change-over control of the loop gain of a tracking servo system based on precognition of defects, such as a blemish, etc. may be performed by the +secondary diffracted light.

[Translation done.]

* NOTICES *

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2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the configuration of the optical system in the optical head which shows the example of this invention.

[Drawing 2] It is drawing showing the gestalt of implementation of this invention.

[Drawing 3] It is the top view showing arrangement of the beam spot of the laser beam irradiated by the optical disk of drawing 1.

[Drawing 4] It is the block diagram showing one example of the signal-processing network of the light-receiving output of the optical head 18 of drawing 1.

[Drawing 5] It is the explanatory view of asymmetry.

[Drawing 6] It is drawing showing the laser beam intensity distribution at the time of the record on the line L which met in the array direction of the beam spot of drawing 1, and playback.

[Drawing 7] It is drawing showing the flows of control of laser beam reinforcement based on measurement of the asymmetry value by the laser beam adjustment device 22 of drawing 1 on the strength.

[Drawing 8] It is drawing showing the configuration of the optical system in the optical head which shows other examples of this invention.

[Drawing 9] It is drawing showing the example of change of the light-receiving signal level by the blemish of a disk etc.

[Description of Notations]

10 10' Optical disk record regenerative apparatus

18 18' Optical head

22 Laser Beam Adjustment Device on the Strength

24 Verification Means

26 Tracking Servo System

28 Truck Quality Judging Means

36 Semiconductor Laser

44 Zero-order Diffracted Light

44a The beam spot of the zero-order diffracted light

45 +Primary Diffracted Light

45a The beam spot of the +primary diffracted light

46 -Primary Diffracted Light

46a The beam spot of the -primary diffracted light

47 +Secondary Diffracted Light

47a The beam spot of the +secondary diffracted light

48 -Secondary Diffracted Light

48a The beam spot of the -secondary diffracted light

56, 58, 60 Truck

66 66' Photodetector

114,114' Optical system

[Translation done.]

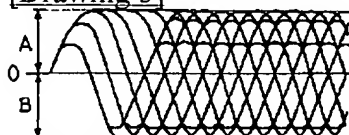
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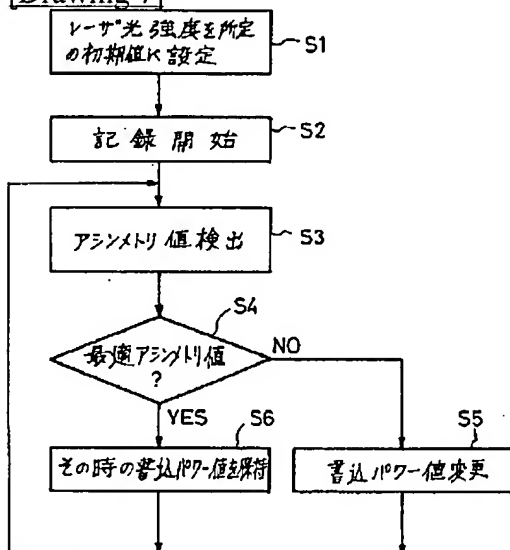
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DRAWINGS

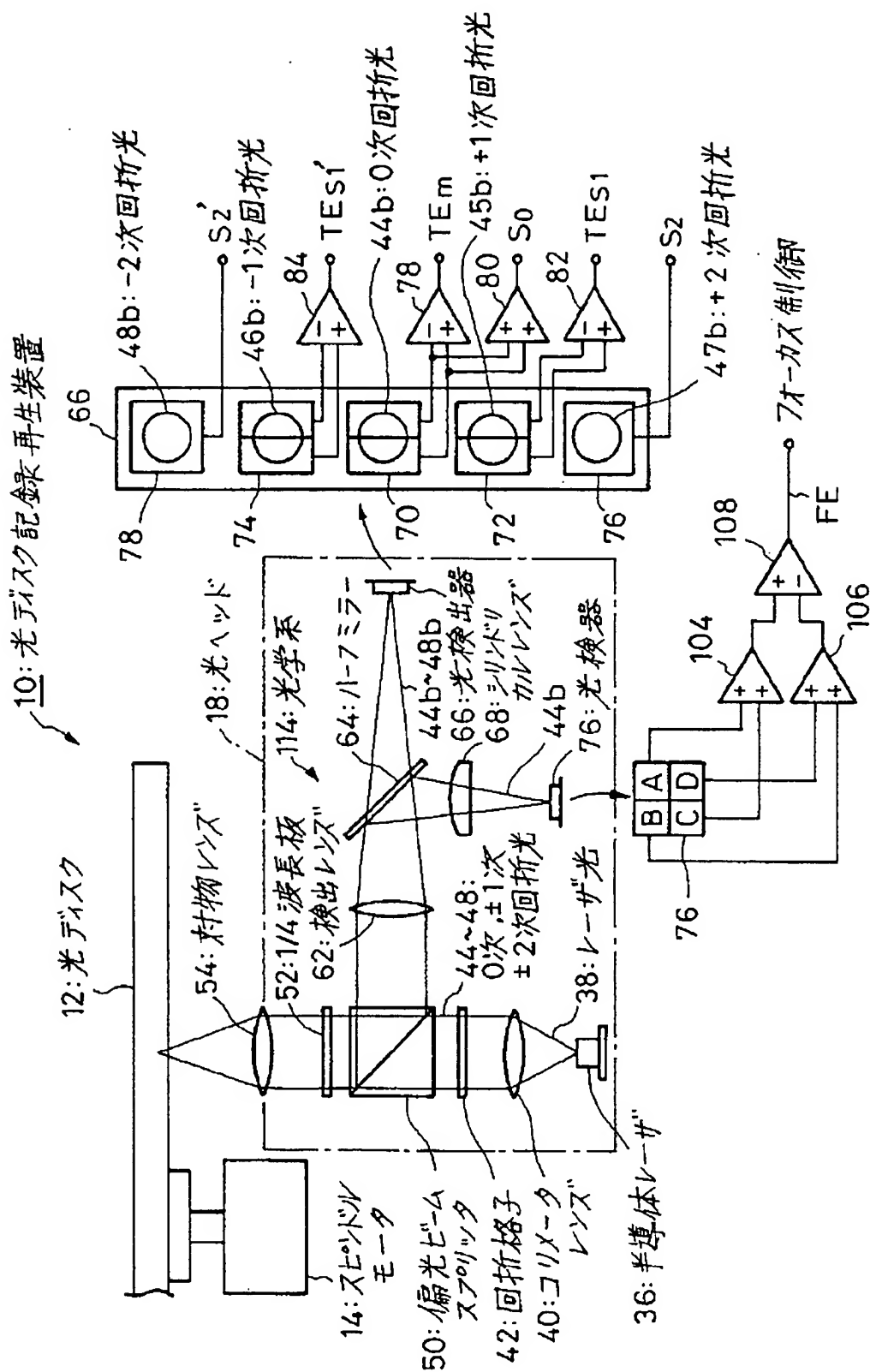
[Drawing 5]



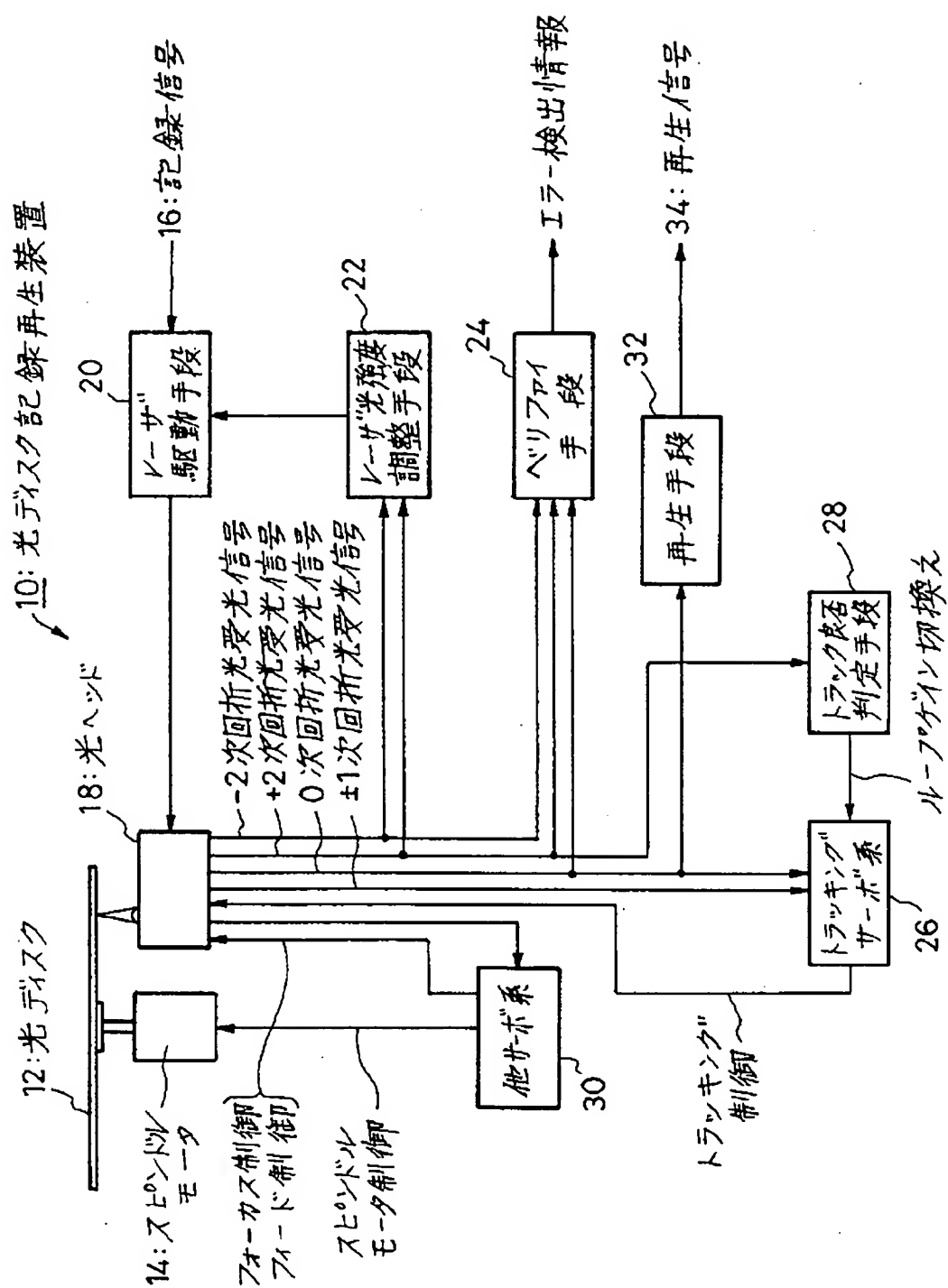
[Drawing 7]



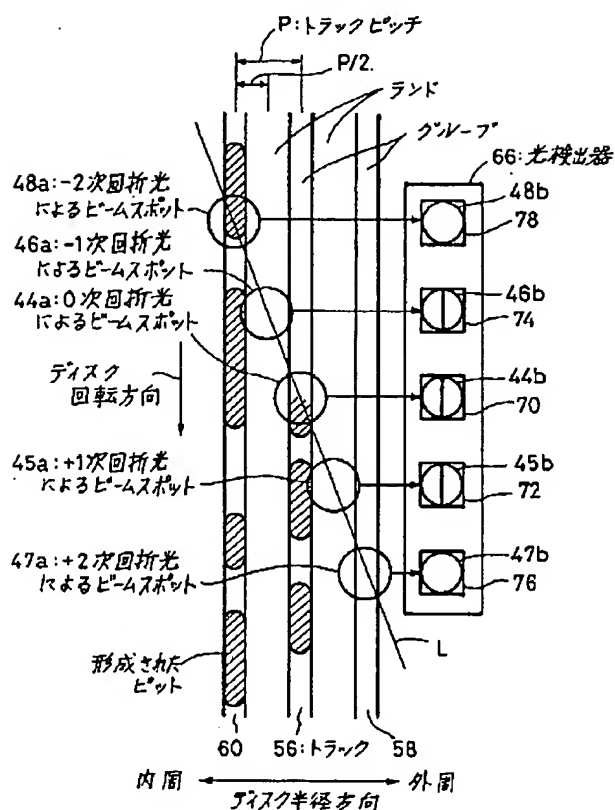
[Drawing 1]



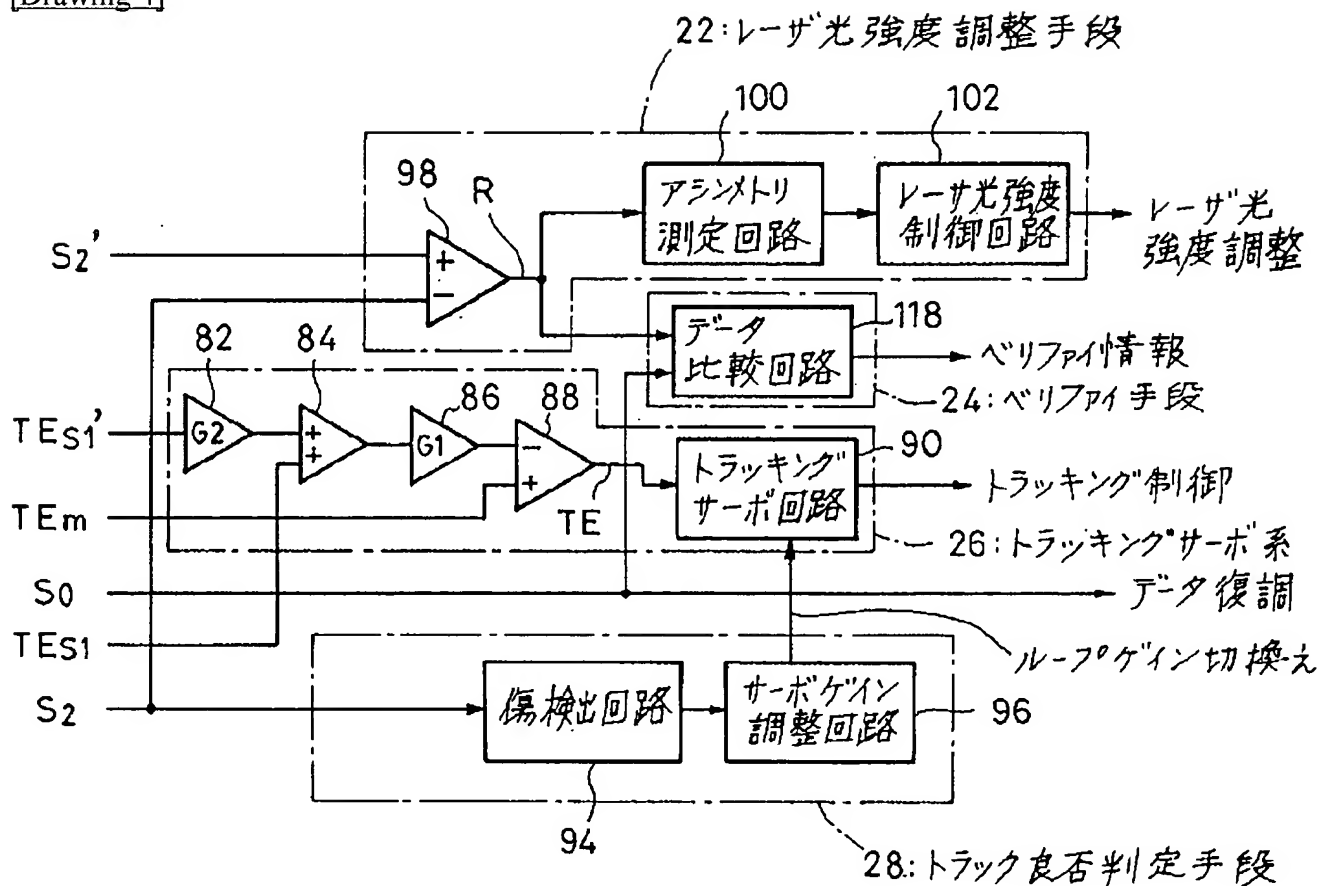
[Drawing 2]



[Drawing 3]

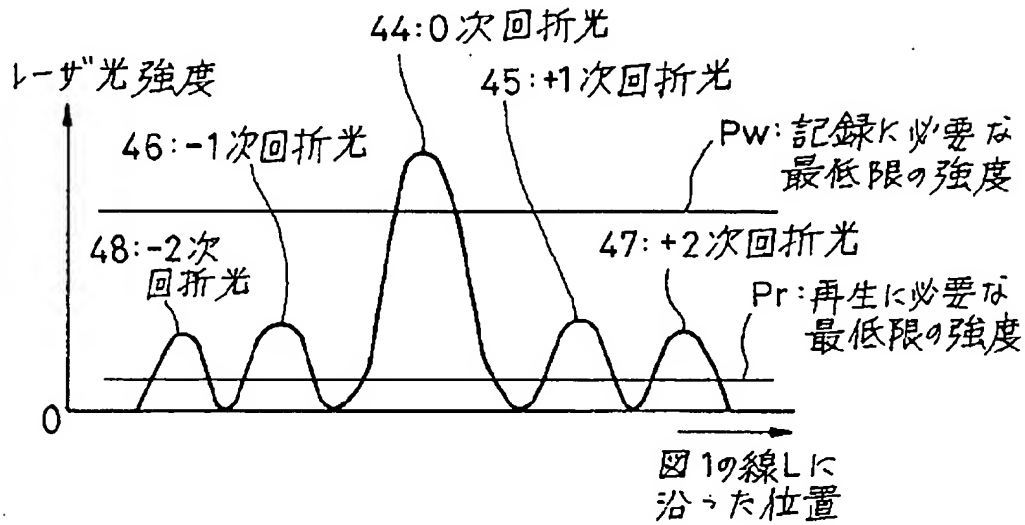


[Drawing 4]

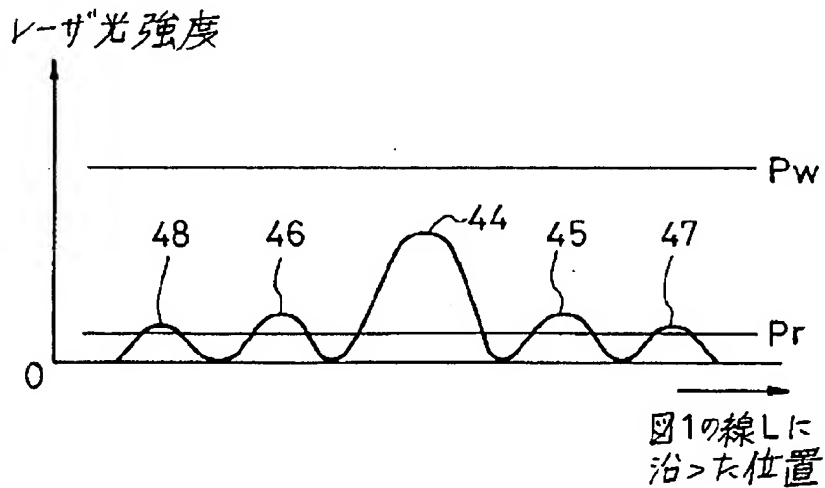


[Drawing 6]

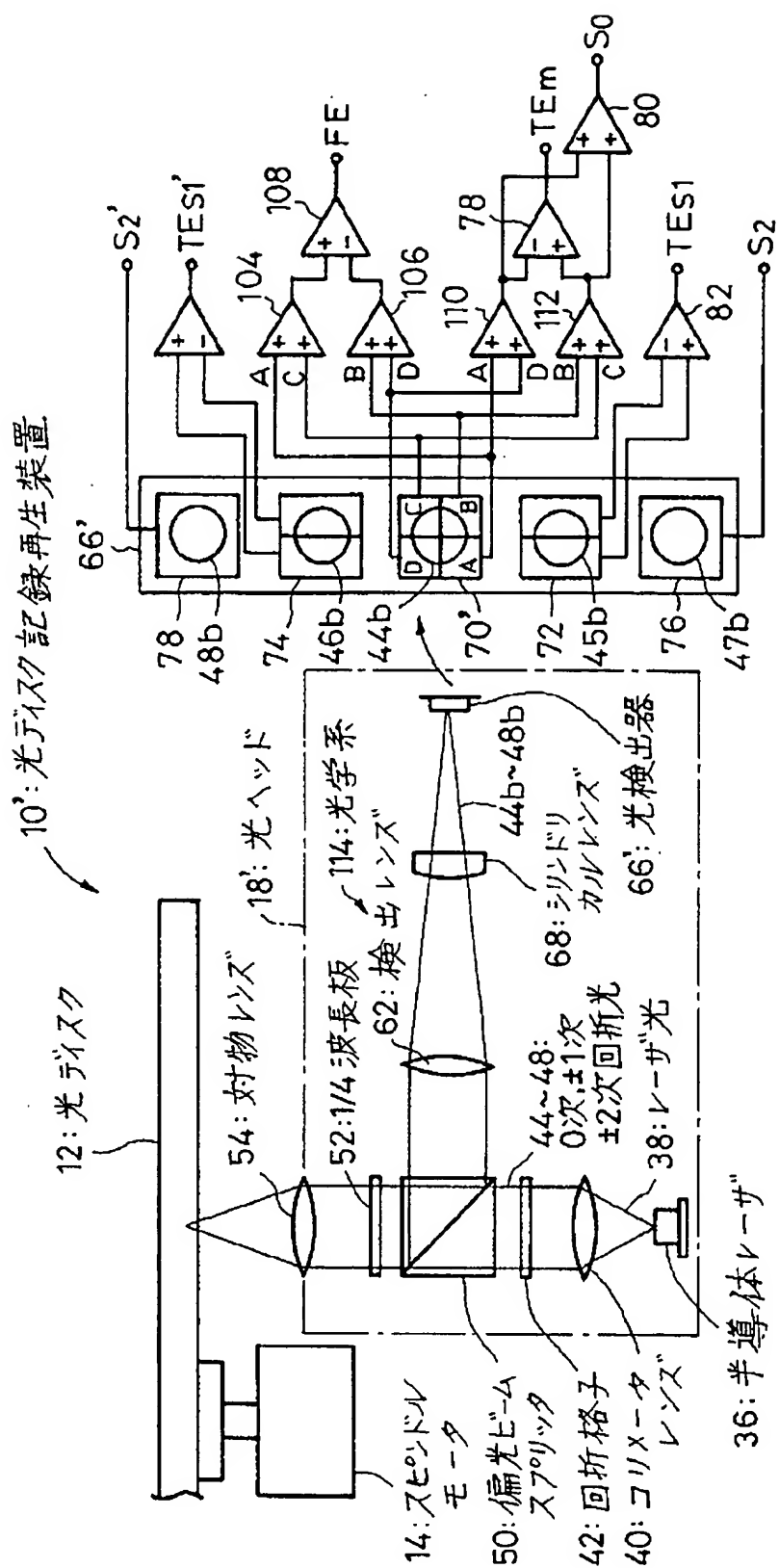
(a) 記録時のディスク記録面上でのレーザ光強度分布



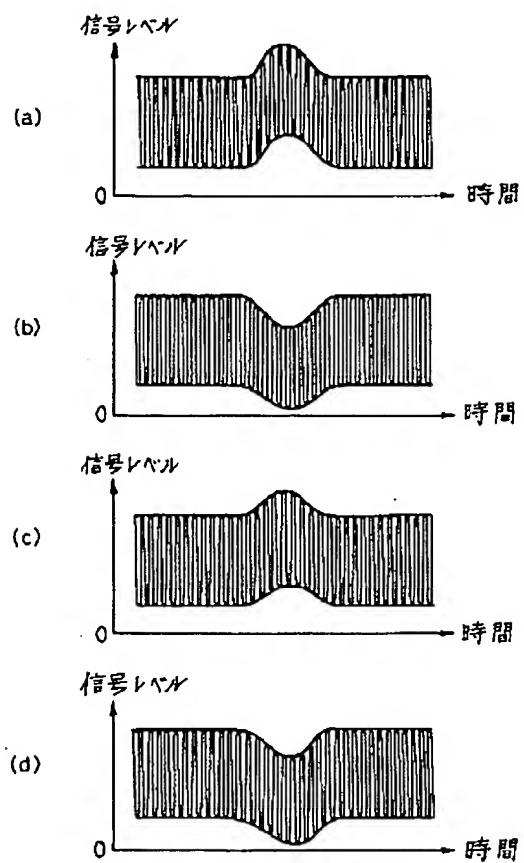
(b) 再生時のディスク記録面上でのレーザ光強度分布



[Drawing 8]



[Drawing 9]



[Translation done.]

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DOCUMENT-IDENTIFIER: JP 10106018 A

TITLE: OPTICAL HEAD AND OPTICAL DISK RECORDER

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INVENTOR-INFORMATION:

NAME

NAGANO, HISASHI

ASSIGNEE-INFORMATION:

NAME

YAMAHA CORP

COUNTRY

N/A

APPL-NO: JP08277571

APPL-DATE: September 27, 1996

INT-CL (IPC): G11B007/135

ABSTRACT:

PROBLEM TO BE SOLVED: To make possible optimum laser power adjustment, verification and foreseeing of a scratch, etc., of a disk in real-time at a recording time while performing precise tracking using a differential tracking system by dividing laser beam from a semiconductor to five pieces of diffracted light and detecting them.

SOLUTION: The laser beam outgoing from a semiconductor laser is divided into five pieces of beam of zero-order diffracted beam, +1st-order diffracted beam and +2nd-order diffracted beam, and they are placed as follows to be detected individually. When the beam spot 44a of the zero-order diffracted beam is placed on a track 56, the beam spot 47a of +2nd-order diffracted beam is placed on the an external track 58 adjacent to it, and the beam spot 45a of the +1st-order diffracted beam is placed on the middle of them. Further, the beam spot 48a of -2nd diffracted beam is placed on the an internal track 60 adjacent to the track 56 on which the beam spot 44a of the zero-order diffracted beam is placed, and the beam spot 46a of -1st-order diffracted beam is placed on the middle between the beam spot 44a of the zero-order diffracted beam and the beam spot 48a of the -1st-order diffracted beam.

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(71)出願人 000004075

ヤマハ株式会社

静岡県浜松市中沢町10番1号

(72)発明者 永野 尚志

静岡県浜松市中沢町10番1号 ヤマハ株式会社内

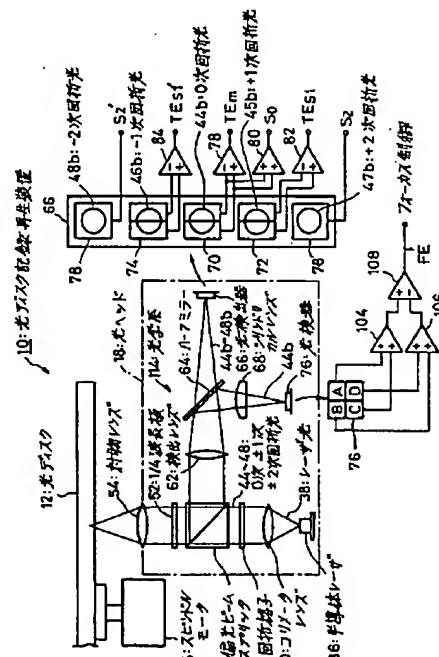
(74)代理人 弁理士 加藤 邦彦

(54)【発明の名称】 光ヘッドおよび光ディスク記録装置

(57)【要約】

【課題】 差動トラッキング方式を用いた高精度のトラッキングを行いつつ、記録時にリアルタイムでの最適レーザーパワー調整、ベリファイ、ディスク上の傷の予知等を可能にする。

【解決手段】 半導体レーザー36から出射されたレーザー光38を回折格子42で0次回折光、±1次回折光および±2次回折光の5本の光に分割する。0次回折光のビームスポット44aが1本のトラック56上に位置しているときに、+2次回折光のビームスポット47aはそれに隣接する1本外側のトラック58上に位置し、+1次回折光のビームスポット45aはそれらの中間に位置し、-2次回折光のビームスポット48aは0次回折光のビームスポット44aが位置しているトラック56に隣接する1本内側のトラック60上に位置し、-1次回折光のビームスポット46aは0次回折光のビームスポット44aと-2次回折光のビームスポット48aの中間に位置する。



【特許請求の範囲】

【請求項1】1本のレーザ光を出射する半導体レーザと、
この半導体レーザのレーザ光出射側に配置されて、当該出射されたレーザ光を0次回折光、±1次回折光および±2次回折光の少なくとも5本の光に分割する回折格子と、
前記0次回折光のビームスポットが光ディスクの1本のトラック上に位置しているときに、前記+2次回折光のビームスポットがそれに隣接する1本外側のトラック上に位置し、前記+1次回折光のビームスポットが前記0次回折光のビームスポットと前記+2次回折光のビームスポットの中間に位置し、前記-2次回折光のビームスポットが前記0次回折光のビームスポットが位置しているトラックに隣接する1本内側のトラック上に位置し、前記-1次回折光のビームスポットが前記0次回折光のビームスポットと前記-2次回折光のビームスポットの中間に位置するように、これら0次回折光、±1次回折光および±2次回折光を光ディスクの記録面に共通に導く光学系と、
前記0次回折光、±1次回折光および±2次回折光、または前記0次回折光、±1次回折光および+2次回折光もしくは-2次回折光のディスクからの各反射光を個別に検出する複数の受光面を有する光検出器とを具備してなる光ヘッド。
【請求項2】前記請求項1の光ヘッドを用いて、前記レーザ光を記録信号で変調して光ディスクに照射し、当該ディスクの内周側のトラックから外周側のトラックに順次記録を行う光ディスク記録装置であって、
前記半導体レーザから出射する記録用レーザ光の強度を、前記0次回折光が記録に必要な光強度を有し、前記±1次回折光および±2次回折光が記録に必要な光強度を有さず再生に必要な光強度を有するように調整し、かつ前記0次回折光で記録を行いながら前記光検出器で検出される-2次回折光の受光信号に含まれる再生信号成分のアシンメトリ値を求めて、所定のアシンメトリ値が得られるように前記半導体レーザから出射する記録用レーザ光の強度をリアルタイムで制御するレーザ光強度調整手段と、
記録時に前記光検出器で検出される0次回折光および±1次回折光の受光信号を用いて差動プッシュプル法によりトラッキングエラーを検出してトラッキング制御を行うトラッキングサーボ系とを具備してなる光ディスク記録装置。
【請求項3】前記請求項1の光ヘッドを用いて、前記レーザ光を記録信号で変調して光ディスクに照射し、当該ディスクの内周側のトラックから外周側のトラックに順次記録を行う光ディスク記録装置であって、
前記半導体レーザから出射する記録用レーザ光の強度を、前記0次回折光が記録に必要な光強度を有し、前記

±1次回折光および±2次回折光が記録に必要な光強度を有さず再生に必要な光強度を有するように調整するレーザ光強度調整手段と、
記録時に前記光検出器で検出される0次回折光および±1次回折光の受光信号を用いて差動プッシュプル法によりトラッキングエラーを検出してトラッキング制御を行うトラッキングサーボ系と、
記録時に前記前記光検出器で検出される-2次回折光の受光信号に含まれる再生信号成分ともの記録信号とを比較して、光ディスクに記録されたデータのベリファイを行うベリファイ手段とを具備してなる光ディスク記録装置。
【請求項4】前記請求項1の光ヘッドを用いて、前記レーザ光を記録信号で変調して光ディスクに照射し、当該ディスクの内周側のトラックから外周側のトラックに順次記録を行う光ディスク記録装置であって、
前記半導体レーザから出射する記録用レーザ光の強度を、前記0次回折光が記録に必要な光強度を有し、前記±1次回折光および±2次回折光が記録に必要な光強度を有さず再生に必要な光強度を有するように調整するレーザ光強度調整手段と、
記録時に前記光検出器で検出される0次回折光および±1次回折光の受光信号を用いて差動プッシュプル法によりトラッキングエラーを検出してトラッキング制御を行うトラッキングサーボ系と、
記録時に前記光検出器で検出される+2次回折光の受光信号を用いて記録前のトラックの良否の判定を行い、不良と判定した場合に、前記トラッキングサーボ系のループゲインを低下させるトラック良否判定手段とを具備してなる光ディスク記録装置。
【発明の詳細な説明】
【0001】
【発明の属する技術分野】この発明は新規な構成の光ヘッドおよびこの光ヘッドを用いた光ディスク記録装置に関し、差動トラッキング方式を用いた高精度のトラッキングを行いつつ、記録時にリアルタイムでの最適レーザパワー調整、ベリファイ、ディスク上の傷の予知等を可能にしたものである。
【0002】
【従来の技術】
（1） トラッキング制御
従来の光ディスク記録装置のトラッキング制御方式は、3ビーム法やプッシュプル法が一般的であった。3ビーム法は、メインビームの前後に2本のサブビームをトラック中心から左右方向にややずらして照射し、この2本のサブビームのディスク反射光量の差を検出してトラッキングエラーを検出するものである。プッシュプル法は、ディスク上のピットや案内溝で反射回折された光をトラック中心に対して対称配置された2分割光検出器で受光して、その2つの受光部での受光量の差によりトラ

ッキングエラーを検出するものである。

【0003】3ビーム法は、再生用としては最も安定な方法であるが、これを記録用に使用すると、先行するサブビームのスポットは未記録部を通過するのに対し、後行するサブビームのスポットは既記録部を通過するため、反射光量が異なって、トラッキングエラー信号にオフセットが生じる欠点があった。

【0004】一方、プッシュプル法では、対物レンズがシフトしたり、ディスク径方向にそり、傾き等が生じていると、トラッキングエラー信号にオフセットが生じ、トラッキング追従量が十分に確保できなくなる欠点があった。

【0005】これら従来の3ビーム法やプッシュプル法の欠点を解消したトラッキング制御方式として、いわゆる差動プッシュプル法と呼ばれているものがある。これは、3つのビームスポットをトラック前後方向の位置でトラック左右方向に1/2トラックピッチずつずらして配置し、各スポットの反射光を2分割光検出器でそれぞれ検出し、各2分割検出器ごとに2信号を引算して3つのプッシュプル信号を得て、これらをオフセットを打ち消すように所定の演算式で演算してトラッキングエラーを検出するようにしたものである。

【0006】(2) 最適書込パワーの設定

光ディスク記録時のレーザ光の最適書込パワーは光ディスクの種類によって異なるため、入力信号の実際の記録(実記録)を行うのに先立って予め試し書きを行って最適書込パワーが設定される。例えば、CD-Write Once (CD-WO) 規格では、この試し書きを行うエリアがPCA (Power Calibration Area) としてディスクの最内周に設けられておりOPC (Optimum Power Control) と呼ばれる一連の動作によって最適書込パワーが設定される。

【0007】従来の光ディスク記録装置におけるOPC動作は、書込パワーをあるステップずつ変化させてテスト記録を行い、このテスト記録したエリアを再生してアシンメトリ値(HF信号の非対称性を示す指標)を算出し、最適アシンメトリ値とされる値(例えば0.04)が得られる書込パワー値を最適書込パワー値として定めて、これを実記録時の書込パワー値として設定していた。

【0008】(3) 最適書込パワーを保持して書込を行うための書込パワー制御

実記録に先立ち、最適書込パワーで記録した光ディスクの記録部分の反射光レベルを検出し、サンプルホールド回路でその反射光レベルをサンプルホールドし、AD変換回路でそのレベルをAD変換し、演算回路でその値を加工し、CPUにその値をALPC (Automatic Laser Power Control) の目標値として記憶する。

【0009】そして、実記録時には、随時記録部分の反射光レベルを検出し、前記サンプルホールド回路でその

反射光レベルをサンプルホールドし、AD変換回路でそのレベルをAD変換し、前記演算回路でその値を加工し、ALPC回路で前記CPUに記録されている目標値とその値が一致するように、記録レーザパワーを制御する。

【0010】(3) ベリファイ

実記録終了後に記録した部分を再生し、もとの記録データと対比してベリファイを行う。

【0011】

- 10 【発明が解決しようとする課題】従来の光ディスク記録装置は、OPC動作が実記録に先立って行われるため、実記録を開始するまでに時間がかかる問題があった。また実記録を行いながらのALPC動作は、複雑な回路構成が必要で部品点数が多く、コストアップやサイズアップにつながる問題があった。また、一旦OPC動作によって最適記録レーザパワーを求めて実記録を行っても、ディスク径方向位置による記録時の特性のばらつき等による最適レーザパワー値の変動には対応することができなかった。また、ベリファイは実記録終了後に記録部分を再生して行うため、実記録開始からベリファイ終了まで長い時間を要していた。また、ディスクに傷がついていると、実記録時にエラーを起こし、書込み不能になることがあった。

【0012】この発明は、前記従来の技術における問題点を解決して、差動トラッキング方式を用いた高精度のトラッキングを行いつつ、記録時にリアルタイムでの最適レーザパワー調整、ベリファイ、ディスク上の傷の予知等を可能にした光ヘッドおよびこの光ヘッドを用いた光ディスク記録装置を提供しようとするものである。

- 30 【0013】

【課題を解決するための手段】この発明の光ヘッドは、1本のレーザ光を0次回折光、±1次回折光および±2次回折光の少なくとも5本の光に分割し、0次回折光のビームスポットが光ディスクの1本のトラック上に位置しているときに、+2次回折光のビームスポットがそれに隣接する1本外側のトラック上に位置し、+1次回折光のビームスポットが0次回折光のビームスポットと+2次回折光のビームスポットの中間に位置し、-2次回折光のビームスポットが0次回折光のビームスポットが位置しているトラックに隣接する1本内側のトラック上に位置し、-1次回折光のビームスポットが0次回折光のビームスポットと-2次回折光のビームスポットの中間に位置するように、それぞれ配置し、各回折光のディスクからの反射光を個別に検出する(ただし、±2次回折光については、使用形態によっては、+2次回折光あるいは-2次回折光の一方の反射光のみを受光するだけで足りる場合もある。)ようにしたものである。

- 40 【0014】また、この発明の光ディスク記録装置は、上記光ヘッドを用いて、レーザ光を記録信号で変調して光ディスクに照射し、ディスクの内周側のトラックから

外周側のトラックに順次記録を行う光ディスク記録装置であって、0次回折光を用いて記録を行い、0次光および±1次回折光の受光信号を用いて差動プッシュプル法によりトラッキング制御を行うようにしている。また、-2次回折光（記録用0次回折光に後行する光）の受光信号に含まれる再生信号成分のアシンメトリ値を検出して、0次回折光で記録を行いながら最適パワー調整を行ったり、-2次回折光の受光信号に含まれる再生信号成分ととの記録信号とを比較することにより、0次回折光で記録を行いながらベリファイを行うようにしている。また、+2次回折光（記録用0次回折光に先行する光）を用いて記録前のトラックの傷等の欠陥を検出して、欠陥が検出された場合には、トラッキングサーボ系のループゲインを低下させることにより、傷によるトラック外れを防止するようにしている。

【0015】なお、記録時の-2次回折光の受光信号には、再生信号成分のほか記録信号成分が含まれているので、最適パワー調整やベリファイにおいては、-2次回折光の受光信号から記録信号成分を除去して再生信号成分のみを抽出する。-2次回折光の受光信号から記録信号成分を除去する方法としては、例えば未記録トラック上をトレースしている+2次回折光の受光信号が記録信号成分のみからなるので、-2次回折光の受光信号から+2次回折光の受光信号を引き算する方法がある。あるいは、+2次回折光の受光信号に代えて、記録前の信号そのもの（半導体レーザの駆動信号）を用いて-2次回折光の受光信号から引き算することもできる。

【0016】以上のように、この発明の光ディスク記録装置によれば、差動トラッキング方式を用いた高精度のトラッキングを行いつつ、記録時にリアルタイムでの最適レーザパワー調整、ベリファイ、ディスク上の傷の予知等が可能である。

【0017】

【発明の実施の形態】この発明の実施の形態を以下説明する。図2はこの発明を適用した光ディスク記録再生装置10の概要を示すものである。光ディスク12は例えばCD-WO規格の追記型ディスクで、スピンドルモータ14によって回転駆動されて、光ヘッド18で信号の記録および再生が行われる。

【0018】記録信号16は、例えばCD-WO規格に従ってEFM変調された信号である。レーザ駆動手段20は、記録時に光ヘッド18内の半導体レーザを記録信号16に従って駆動して、0次回折光により光ディスク12に当該信号の記録（ピットの形成等）を行う。レーザ光強度調整手段22は、記録時に-2次回折光の受光信号に含まれる再生信号成分のアシンメトリ値を検出して、最適値として予め定められたアシンメトリ値が得られるように、書込レーザパワーをリアルタイムで調整する。

【0019】ベリファイ手段24は、記録時に-2次回

折光の受光信号に含まれる再生信号成分ととの記録信号とを比較してベリファイを行う。ベリファイの結果エラーが検出された場合には、エラー検出情報を出してエラー検出の表示、記録のやり直し等を行う。

【0020】トラッキングサーボ系26は記録時および再生時に、±1次回折光および0次回折光の受光信号を用いて差動プッシュプル法によりトラッキングエラーを検出して、光ヘッド18のトラッキング制御を行う。トラック良否判定手段28は記録時および再生時に+2次回折光の受光信号（HF信号）の異常状態（例えば、HF信号がくびれてエンベロープ信号レベルが大きく上下動する等）を検出することにより、記録直前のトラックにおける傷、指紋、ホコリ、記録膜不良等の欠陥を検出して、そのトラック上の位置が記録位置（0次回折光の位置）を通過する間トラックサーボのループゲインを低下させて、不要なトラック外れを防止する。

【0021】他のサーボ系30は、記録時および再生時に0次回折光の受光信号を用いてフォーカスサーボおよびスピンドルサーボを行う。また、フィードサーボ（光ヘッド18のディスク径方向への移動制御）も行。再生手段32は、再生時に0次回折光の受光信号により光ディスク12の記録情報の再生を行い、再生信号34を出力する。

【0022】

【実施例1】図2の光ヘッド18内の構造の具体例を図1に示す。光ヘッド18は半導体レーザ36から1本のレーザ光38を出射し、コリメータレンズ40で平行光に変換し、回折格子42で5本のビーム（0次回折光44、+1次回折光45、-1次回折光46、+2次回折光47、-2次回折光48）に分ける。この5本のビーム44～48は、偏光ビームスプリッタ50を直進して、さらに1/4波長板52および対物レンズ54を通して光ディスク12の記録面に照射される。

【0023】このとき、図3に示すように0次回折光44のビームスポット44aは光ディスク12の1本のトラック（グループ）56上に位置し、+2次回折光47のビームスポット47aはそれに隣接する1本外側のトラック58上に位置し、+1次回折光45のビームスポット45aは0次回折光44のビームスポット44aと+2次回折光47のビームスポット47aの中間に位置し、-2次回折光48のビームスポット48aは0次回折光44のビームスポット44aが位置しているトラック56に隣接する1本内側のトラック60上に位置し、-1次回折光46のビームスポット46aは0次回折光44のビームスポット44aと-2次回折光48のビームスポット48aの中間に位置している。これにより、5個のビームスポット44a～48aは、1/2トラックピッチずつディスク径方向に位置をずらして配置される。このようなビームスポット44a～48aの配置は、回折格子42の配置（トラック方向に対する格子方

向の角度設定)によって実現される。

【0024】図1において、5本のレーザ光44~48の光ディスク12からの反射光44b~48bは、対物レンズ54を通して偏光ビームスプリッタ50で直角に曲げられ、検出レンズ62で集束光に変換され、一部がハーフミラー64を直進して光検出器66で受光される。また、他の一部がハーフミラー64で直角に曲げられて、シリンドリカルレンズ68を通して0次回折光44bが光検出器76で受光される。

【0025】光検出器76は4分割PINフォトダイオードで構成され、フォーカス制御に用いられる。すなわち、4分割光検出器76は0次回折光44bを受光し、その4つの受光出力は加算器104、106で対角位置の出力どうしが加算され、その結果得られる2つの加算出力が引算器108で引算されて、フォーカスエラー信号FEが作成される。フォーカスエラー信号FEに基づいてフォーカス制御が行われる。

【0026】光検出器66はPINフォトダイオードで構成され、中央に0次回折光44bを受光する2分割受光素子70を配し、その前後に+1次回折光45b、-1次回折光46bを受光する2分割受光素子72、74を配している。さらにその前後に、+2次回折光47b、-2次回折光48bを受光する無分割受光素子76、78を配している。

【0027】2分割受光素子70で受光された0次回折光44bの2つの受光出力は、引算器78で引算されて、信号TE_mが作成され、また加算器80で加算されて信号Soが作成される。2分割受光素子72で受光された+1次回折光45bの2つの受光出力は、引算器82で引算されて、信号TEs1が作成される。2分割受光素子74で受光された-1次回折光46bの2つの受光出力は、引算器84で引算されて、信号TEs1'が作成される。受光素子76は+2次回折光47bを受光して、受光信号S2を出力する。受光素子78は-2次回折光48bを受光して、受光信号S2'を出力する。

【0028】これら信号TE_m、So、TEs1、TEs1'、S2、S2'の信号処理系統を図4に示す。トラッキングサーボ系26は、メインスポット(0次回折光)とサイドスポット(±1次回折光)それぞれのプッシュプル信号を検出し、その差をとってトラッキングエラー信号を求める。すなわち、信号TEs1'に対してアンプ82でゲインG2を付与し、加算器84でこれと信号TEs1を加算し、さらにその加算出力に対しアンプ86でゲインG1を付与し、引算器88で信号TE_mを引算して、差動プッシュプル方式によるトラッキングエラー信号TEとして、

$TE = TE_m - G1 (TEs1 + G2 \cdot TEs1')$

を出力する。トラッキングサーボ回路90は、この信号TEに基づきトラッキング制御を実行する。

【0029】なお、ゲインG1、G2は、0次回折光4

4b、+1次回折光45b、-1次回折光46bの受光信号レベルを描えるためのもので、0次回折光44bと±1次回折光45b、46bの光量比をI₀:I₁(+1次回折光45bと-1次回折光46bの受光信号レベルは等しいものとする。)とすると、

$$G1 = I_0 / 2 I_1$$

$$G2 = I_1 / I_1 = 1$$

となる。

【0030】トラック良否判定手段28は、傷検出回路94で+2次回折光の受光信号S2の異常状態(例えば、HF信号がくびれてエンベロープ信号レベルが大きく上下動する等)を検出する(例えば、ある基準レベルを設定して、HF信号のエンベロープを検出して、検出されるエンベロープ信号レベルがこの基準レベルを下回るあるいは上回ることを検出する)ことにより、記録位置の1トラック前に傷等の欠陥があると判定し、トラッキングゲイン調整回路96により、その欠陥位置が記録位置を通過するまでの間トラッキングサーボ系26のループゲインを所定の値に低下させる。

【0031】なお、トラック良否判定手段28は再生時にもエラー検出を行って、エラーが検出されたときに、欠陥位置が0次回折光44による再生位置を通過するまでの間トラッキングループ26のゲインを所定の値に低下させることにより、音飛びその他の再生エラーを防止することができる。

【0032】トラックの傷等による+2次回折光の受光信号レベルの変化の具体的な例を図9(a)~(d)に示す。トラックの欠陥としては、ディスクの表面上のものとして、傷、指紋付着、ほこり等があり、ディスクの内部のものとしては、記録膜自身のピンホール欠陥等がある。図9(a)は、記録時においてディスク内部にピンホール等があった場合であり、反射率が上がっている。図9(b)は、記録時においてディスク表面に傷、指紋、ほこり等があった場合を示し、この場合は反射率が下がる。図9(c)は、記録時にほこり等が介在したため、信号記録がなされなかった部分を再生した場合であって、このような場合には、反射率が上がる。また図9(d)は、再生時にディスク表面に傷、指紋、ほこり等が存在した場合で、反射率が下がる。

【0033】レーザ光強度調整手段22は、引算器98で-2次回折光の受光信号S2'(記録信号成分と再生信号成分を含む信号)から+2次回折光の受光信号S2(記録信号成分のみ含む信号)を引算して、再生信号成分のみからなる信号Rすなわち

$$R = S2' - S2$$

を作成する。この信号Rはアシンメトリ測定回路100に入力されて、実記録しながらアシンメトリ値が検出される。アシンメトリ値は図5に示すような-2次回折光のアイパターンにおいて、+側の波高値をA、-側の波高値をBとして、例えば次式により求められる。

【0034】アシンメトリ値(%) = $\{(B-A) \div 2 (B+A)\} \times 100$

アシンメトリ測定回路100は波高値A, Bを検出して、上式によりアシンメトリ値を算出する。

【0035】レーザ光強度調整回路102は、半導体レーザ36から出射するレーザ光38の強度を制御する。すなわち、記録時は図6(a)に示すように、0次回折光44が記録に必要な最低限の強度Pwよりも高くなり、±1次回折光45, 46、±2次回折光47, 48が記録に必要な最低限の強度Pwよりも低く再生に必要*10

〔再生時〕〔

*な最低限の強度Prよりも高くなるようにレーザ光38の強度を設定する。また、再生時は図6(b)に示すように、全回折光44~48がいずれも記録に必要な最低限の強度Pwよりも低く、再生に必要な最低限の強度Prよりも高くなるようにレーザ光38の強度を設定する。記録用レーザ光強度の規格値を4~8mWとし、再生用レーザ光強度の規格値を0.7mW未満とした場合の各回折光の記録時および再生時の強度の一例を次表に示す(単位はmW)。

【0036】

記 録 時

(1倍速) (2倍速) (4倍速)

0次回折光: ~0.7 4~8 5.5~11 8~16

±1次回折光: ~0.7 ~1 ~1.5 ~2

±2次回折光: ~0.7 ~0.7 ~0.7 ~0.7

【0037】また、レーザ光強度調整回路102は、記録時にはアシンメトリ測定回路100で検出されるアシンメトリ値(すなわち、0次回折光44で記録された光ディスク12上の記録部分を次の周回で-2次回折光48によって検出した受光信号中の再生信号成分のアシンメトリ値)が、最適とされるアシンメトリ値(例えば0.04)になるように、レーザ光38の強度をリアルタイムで微調整する。この微調整には従来のALPC制御におけるサンプルホールドやAD変換は不要なので回路構成が簡単で済む。

【0038】この微調整は、例えば図7に示すようなフローに従って行うことができる。すなわち、記録開始当初はレーザ光強度を所定の初期値に設定して(S1)、記録を開始する(S2)。あるいは、予めOPC動作によって最適レーザパワー値を求めて、それを初期値として設定してもよい。記録開始後はアシンメトリ測定回路100でアシンメトリ値を検出し(S3)、最適アシンメトリ値かどうかを判定し(S4)、最適アシンメトリ値から外れている場合はレーザ光強度を調整し(S5)、最適アシンメトリ値が得られている時はその時のレーザ光強度を保持する(S6)。

【0039】なお、記録開始当初にOPC動作を行わずにレーザ光強度を適切な初期値に設定する方法としては、例えば次の方法が考えられる。すなわち、未記録ディスクにはディスク種類を識別するためのディスクIDが予め記録されている。そこで、ディスク種類ごとの最適記録パワー値の標準値(例えば、ID=1(〇〇社の××ディスク)のときは6mW、ID=2(△△社の□□ディスク)のときは7.5mW等)を記憶したROM等を装置に組み込んでおき、記録時にディスクIDを読み込んでディスク種類を識別し、そのディスクについて定められた最適パワー値をROMから読み出して、その値を初期値として記録を開始する。

【0040】以上のようにして、レーザ光強度調整手段22では記録時にリアルタイムでOPC動作およびAL※50

※PC動作が実現される。初期値としてディスクIDを用いれば、事前のOPC動作は不要になる。また、初期値を事前のOPC動作で求める場合でも、記録開始後の径方向位置による最適記録パワー値の変動等に対応できる効果が得られる。

【0041】ベリファイ手段24はデータ比較回路118で信号R(再生信号)と信号So(記録信号)を比較して、ベリファイを行う。これはEFM信号どうしを比較する(ビット列の“1”、“0”を直接対比する。)ことによって簡単に行うことができる。なお、信号Rは信号Soに対して約1周分遅れて検出されるので、この遅れ分だけ信号Soを遅延して比較する。また、信号R、Soを直接比較するのに代えて、信号R、SoをそれぞれEFM復調してから比較することもできる。また、記録信号として、信号Soに代えて、記録前の信号そのもの(半導体レーザの駆動信号あるいはEFM変調前のデータ)を用いて比較することもできる。

【0042】

【実施例2】この発明の他の実施例を図8に示す。図1の実施例と共通する部分には同一の符号を用いる。この光ディスク記録再生装置10'は、光ヘッド18'の光検出器66'内の0次回折光受光素子70'を4分割PINフォトダイオードで構成して、その受光出力を用いてフォーカスエラー検出を併せて行うようにしたものである。したがって、前記図1の実施例におけるハーフミラー64や光検出器76はここでは省かれ、検出レンズ62を出た5本のレーザ光44b~48bはそのままシリンドリカルレンズ68を介して光検出器66'で受光される。0次回折光44bを受光する4分割フォトダイオード70'のうち、トラック進行方向に対し左側にある2つの受光素子A, Dの出力が加算器110で加算され、トラック進行方向に対し右側にある2つの受光素子B, Cの出力が加算器112で加算される。2つの加算出力は引算器78で引算されて信号TE_mが作成される。また、2つの加算出力は加算器80で加算されて信

号S₀が作成される。再生時は信号S₀を用いて再生（データ復調）が行われる。他は実施例1と同じである。

【0043】尚、前記実施の形態では、この発明の光ヘッドを光ディスク記録再生装置に適用した場合について説明したが、光ディスク記録専用装置あるいは光ディスク再生専用装置にも適用することができる。光ディスク再生専用装置に適用する場合には、0次回折光で再生を行い、0次回折光および±1次回折光で差動プッシュプル法によるトラッキング制御を行い、+2次回折光で傷等の欠陥の予知に基づくトラッキングサーボ系のループゲインの切換制御等を行うように構成することができる。

【図面の簡単な説明】

【図1】 この発明の実施例を示す光ヘッド内の光学系の構成を示す図である。

【図2】 この発明の実施の形態を示す図である。

【図3】 図1の光ディスクに照射されるレーザ光のビームスポットの配置を示す平面図である。

【図4】 図1の光ヘッド18の受光出力の信号処理系の一実施例を示すブロック図である。

【図5】 アシンメトリの説明図である。

【図6】 図1のビームスポットの配列方向に沿った線上での記録時および再生時のレーザ光強度分布を示す図である。

【図7】 図1のレーザ光強度調整手段22によるアシンメトリ値の測定に基づくレーザ光強度の制御フローを示す図である。

示す図である。

【図8】 この発明の他の実施例を示す光ヘッド内の光学系の構成を示す図である。

【図9】 ディスクの傷等による受光信号レベルの変化例を示す図である。

【符号の説明】

10, 10' 光ディスク記録再生装置

18, 18' 光ヘッド

22 レーザ光強度調整手段

24 ペリファイ手段

26 トラッキングサーボ系

28 トラック良否判定手段

36 半導体レーザ

44 0次回折光

44a 0次回折光のビームスポット

45 +1次回折光

45a +1次回折光のビームスポット

46 -1次回折光

46a -1次回折光のビームスポット

47 +2次回折光

47a +2次回折光のビームスポット

48 -2次回折光

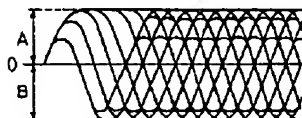
48a -2次回折光のビームスポット

56, 58, 60 トラック

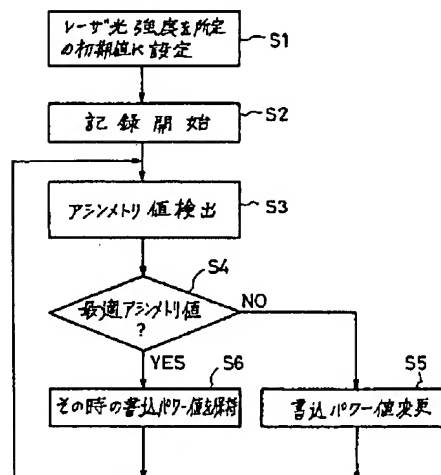
66, 66' 光検出器

114, 114' 光学系

【図5】



【図7】



10: 光ディスク記録再生装置

12: 光ディスク

14: スポントルモータ

16: 記録信号

18: 光ヘッド

20: レーザ駆動手段

22: レーザ光強度調整手段

24: バリアイ手段

30: 他サボ系

32: 再生手段

34: 再生信号

26: トラッキングサーボ系

28: トラック長短判定手段

エラー検出情報

スピンドルモータ制御

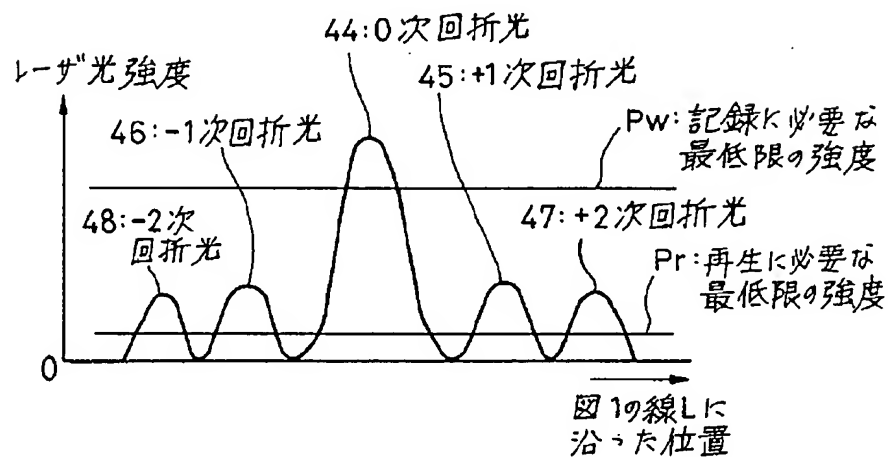
フォーカス制御

トラッキング制御

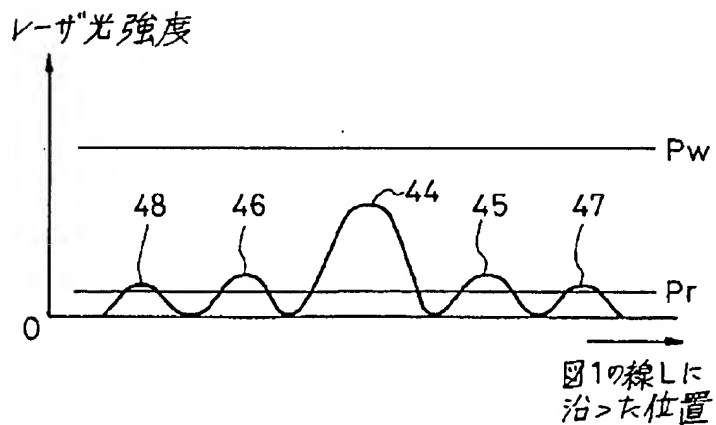
ループゲイン切換え

【図6】

(a) 記録時のディスク記録面上でのレーザ光強度分布



(b) 再生時のディスク記録面上でのレーザ光強度分布



10': 光ディスク記録再生装置

12: 光ディスク

14: スピンドルモータ

50: 偏光ビームスプリッタ

42: 回折格子

40: コリメータレンズ

54: 対物レンズ

52: 1/4波長板

62: 検出レンズ

114: 光学系

44b~48b: 0次±1次±2次回折光

68: シリンドリカルレンズ

66': 光検出器

18: 光ヘッド

78: 48b

74: 46b

44b

70'

72: 45b

47b

66

78

104

108

106

110

112

80

82

TES1'

FE

TE_m

TES1

S2'

S2

36: 半導体レーザ

【図9】

